the autopsied cases the vocal paralysis was attributed to direct compression on the part of the auricle or its appendix in 7; to cardiac displacement, traction, etc., in 1; to the effects of a persistently patulous ductus arteriosus in 2; and to indirect compression acting on the pulmonary artery in 2.

CONCLUSIONS. It is our conviction, based on careful study of the anatomical relations in hardened preparations, that the indirect mechanism may be a variable one, but that when compression is accountable for the recurrent paralysis, it must always be caused by the nerve being squeezed between the left pulmonary artery and the aorta or the aortic ligament.

Anything which will dilate or force upward the left auricle, the left upper pulmonary vein, or the left pulmonary artery would tend to cause the condition.

The anatomic relations are such that direct pressure of any portion of a dilated left auricle upon the aortic arch is impossible.

When we consider the softness of all the structures involved, and the fact that the nerve is normally flattened against the aorta, not rounded, it would seem probable that its function is abolished, not from actual destruction from pressure, but from a neuritis consequent upon a degree of compression which could hardly be sufficient to actually destroy the vitality of the nerve. This, of course, can be determined only by microscopic examination of the nerve.

ARNETH'S METHOD OF BLOOD COUNTING—ITS PROGNOSTIC VALUE IN PULMONARY TUBERCULOSIS.[1]

By C. L. Minor, M.D.,

AND

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THE great difficulty of drawing a correct prognosis in a case of pulmonary tuberculosis is too well known to need more than a mention here.

Those most experienced in the treatment of this disease frequently fail to predict correctly the future course of a case, or to estimate with any degree of accuracy its chances of recovery. Therefore, any procedure which promises to be of assistance in drawing a prognosis demands our attention and study, and hence we feel justified in taking the time of this Association to present the conclusions we have formed from the study of the blood in a hundred cases of pulmonary tuberculosis by Arneth's method.

[1] Read before the American Climatological Association at Old Point, Va., June, 1909.

This method, developed by its author in Leube's clinic in 1904-05, has so far not attracted much attention in this country, though two of the members, of this Association, Dr. A. C. Klebs, and Dr. Geo. E. Bushnell, U. S. A., have made valuable contributions to the subject.

The former reported to the National Association for the Study and Prevention of Tuberculosis in 1906, and expressed the hope that his report might induce further investigation on these lines; but since that time, so far as we know, only Bushnell and Trueholtz have written on the subject.

Wishing to determine the value of this method as an aid to prognosis, we have examined the blood of somewhat over one hundred cases in Dr. Minor's practice, and as a result of this work we believe it has a distinct value in enabling one to estimate the resisting power, and hence the likelihood of recovery and general prognostic outlook, of such cases, and trust it will be more generally used by the profession than has been the case in the past.

As you all know, Arneth considered that the young white cells—those with one or two nuclei—are less resistant and less able to combat an infection than the older ones with more nuclei.

Starting out with this assumption, he counted the number of nuclei in all the neutrophilic white cells, and divided them into five classes, according to the number of their nuclei. Placing these numbers in a horizontal row, beginning on the left with Class I, which contained one nucleus, and ending on the right with Class V, which contained five nuclei, he formed what he called the neutrophilic blood picture. From a count of fifteen normal individuals he formed a normal picture.

I	II	III	IV	V
5 per cent.	35 per cent.	41 per cent.	17 per cent.	2 per cent.

Studying the blood in pulmonary tuberculosis, he found, in consonance with his theory, that the normal percentage of nuclei in the different classes was lost, there being an increase of the younger cells of Classes I and II, and a lessening of the more mature ones in Classes III, IV, and V, this being more marked in proportion to the severity of the trouble—one of the worst pictures he got being a case of miliary tuberculosis:

I	II	III	IV	V
36 per cent.	56 per cent.	8 per cent.	0 per cent.	0 per cent.

And again, in the case of subacute tuberculosis:

I	II	III	IV	V
45 per cent.	52 per cent.	3 per cent.	0 per cent.	0 per cent.

This change he calls a drift or dislocation (Verschiebung) to the left, and takes it as an evidence of a lowered resistance to the disease of the patient whose blood he is studying, as is demonstrated by the fact that, as the case improves, the picture tends to return to the right, and as it gets worse tends to move farther to the left.

With increasing experience with this method we have been more and more forced to believe that whether or not Arneth is right in his views as to the vitality of the neutrophiles of one or two nuclei, as compared with those of three, four, or five nuclei, the findings gotten by such counts agree remarkably well with the actual clinical facts, and that in his method we have a very useful means of drawing a prognosis in our cases of pulmonary tuberculosis.

Klebs and, especially, Bushnell[2] share this view, the latter believing that the drift is a proof that toxic absorption is present in a degree which constitutes a tax on the resistance of the patient.

In our cases we have found, with great but not complete uniformity, that favorable cases show a picture tending toward the right, unfavorable one tending toward the left, very much in proportion to the severity of the case and its outlook for a cure. In advanced and severe cases where, unfortunately, the prognosis is sufficiently evident, the picture is uniformly very bad, as in the following cases: The first, Mr. P. S., was from a very bad case of primary (?) pharyngeal tuberculosis with no pulmonary signs; the second, Mr. H. M. S., was a hopeless case of acute caseous pneumonia, grafted on an old chronic case; the third, Miss G., was a rapidly spreading acute tuberculosis, as was the third, Mrs. G.; while the fifth, Miss B., was an old chronic case with a large cavity in the upper left lobe, and an extensive infiltration in both lungs; while the last was a far advanced chronic case with extensive destruction.

	I	II	III	IV	V	Index.
(1)	41.5	43.5	10.0	2.0	....	93.0
(2)	34.0	45.0	20.0	1.0	...	89.0
(3)	39.0	47.0	11.0	....	....	93.0
(4)	48.0	42.0	8.0	2.0	....	94.0
(5)	54.0	36.0	10.0	....	....	95.0
(6)	55.0	42.0	3.0	....	....	98.5

But in much less advanced cases the method often gives us great assistance and throws unexpected light upon the future course. Not only would an unfavorable picture in a new case, which otherwise seemed fairly favorable, justify a strong suspicion of its outlook, but changes in the picture occurring during treatment can give us valuable hints.

Again, examinations during the course of a case, if not too close together, will generally show a drift to the right or to the left, according as the case is doing well or ill. In several cases we have found an unexpectedly bad picture, apparently not justified by the nature of the case, but whose reliability was only too well substantiated by subsequent developments.

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[2] Loc. cit.

TECHNIQUE. Coming to the technique of the procedure, we would first note that while it is more or less time consuming, it is not difficult to any one familiar with blood work. Our counts have all been done by Dr. Ringer in Dr. Minor's laboratory, with enough controls by Dr. Minor to determine the reliability of the system used. The blood was drawn from a free-flowing puncture in either the ear or the finger, and the resulting drop, which should be about 3 mm. in diameter, was touched to an underlying glass slide, previously washed in 95 per cent. alcohol to remove all fat. This drop was then evenly spread over the slide by slightly sweeping along it the smooth edge of the end of a second glass slide, held approximately at an angle of 45 degrees to the first. The spread must be made lightly to avoid deforming the leukocytes, and is allowed to dry in the air.

We found that the smears necessarily varied in thickness, and in the thicker portions that the leukocytes were smaller, the nuclei closer together, and often superimposed, so that an estimation of the actual number was very difficult; whereas in the thinner portions of the smear the leukocytes were not superimposed and were easy to count. Consequently the thin portions of the smear were always selected for the purpose of counting. To avoid counting the same cells more than once, a mechanical stage was always used.

We have used the Jenner stain in preference to others in our work; consequently allowing the smears to dry without fixation, and kept them in the staining fluid for five minutes.

We also stained smears with both Wright's blood stain and Ehrlich's tri-acid, but we found that Jenner's stain gave us the best nuclear differentiation, and consequently, we adopted this as a routine measure. Klebs, for similar reason, used Wright's stain, and Bushnell and Trueholtz, hematoxylin and eosin.

In every case we counted the nuclei, not of one hundred neutrophiles, which Arneth thought sufficient, but of two hundred, and our percentages were estimated accordingly.

As in numerical blood counts each individual finally adopts a system of his own to which he adheres rigorously, so in this work we found it necessary to formulate certain arbitrary rules, which we have strictly followed, thus making our results comparable.

The chief difficulty has been to determine accurately how many nuclei a given leukocyte possesses, in order to be able to classify it correctly. Even in the thinner portions of the smear numbers of leukocytes will be found whose nuclei are not distinctly separated or only partially so; thus, the problem of correctly estimating the number becomes a very delicate one.

We have in all cases adhered unswervingly to the following rules:

1. Nuclei connected by a distinct isthmus are always to be counted as one nucleus.
2. Nuclei connected only by a thread are always to be considered as two nuclei.
3. Nuclei clearly superimposed are to be considered as separate nuclei, but if the superposition is not definite the nuclei are not to be considered as being separate.

Some may take issue with us as to the legitimacy of some of these rules, but we believe that the specific rule is of minor importance, the main point being that all counts be done by one and the same system, and preferably by the same individual, in order that the results may be really comparable.

As a result of our counts, done with every care, we have not been able to find a normal picture agreeing with that of Arneth, our normal, estimated in the case of ten healthy men, averaging:

I	II	III	IV	V
2.5	18.2	55.6	18.6	5.1

while our normal counts also show more cells from Class III onward, and fewer in Classes I and II, although Klebs, Bushnell and Trueholtz, and Webb and Williams, of Colorado Springs, who are to report shortly at the meeting of the American Medical Association, have agreed much more closely with Arneth. It is evident, therefore, that we have classed as multinuclear cells which they counted as mono- or bi-nuclear.

While we should like to have found ourselves in agreement with our colleagues, we can only repeat the facts as we found them, using, as we believe, the rational rules which we have quoted to guide us, and as the general relation of the pictures given by the different classes of cases is not thereby changed, as our tables show, we do not believe that the lack of agreement vitiates the conclusions we would draw from our counts, although unless the pictures be laid out in graphic curves, it renders it more difficult to compare the findings of different men.

Arneth, with characteristic German thoroughness, in classifying the nuclei has divided them even more minutely, and would distinguish in Class I between those with round nuclei and those with slightly and with deeply indented nuclei, the latter two being older; while in the other cases he separates the nuclei that are in loops from those that are round. Such an elaborate subdivision, while greatly increasing the complexity of the work, does not, we believe, bring compensating advantages, and we think, with Klebs and Bushnell, that it can be neglected.

Arneth lays stress on the fact that the drift to the left is independent of the total number of leukocytes, some people who present a normal leukocyte count showing a badly altered picture. In 33 per cent. of our cases we have made leukocyte counts, and have found this verified to a considerable degree, though, on the whole, the cases with the good pictures were usually those with lower leukocyte counts, while the bad cases usually showed the higher counts.

In our good cases the leukocytes averaged 7988, in our medium cases 9827, and in our bad cases 9258, and in one very bad case, 20,200.

It is evident that the comparison of different pictures, each with its five classes, will not be easy, and Arneth has taken the sum of the cells in Classes I and II to make a standard of comparison; while Bushnell and Trueholtz have sought to make an index for each case by adding together all the nuclei from Classes I and II and half of those in Class III, thus making the index the percentage of the lower half of the picture to the whole picture.

Thus, Arneth's normal picture would yield an average of 60.5 per cent., *i. e.*, 5 × 35, ½ of 41, while Bushnell and Trueholtz get 67, and Webb and Williams 65.

In our cases, since, as we noted, our Classes I and II show less cells, our index was lower, being 48.5 per cent.

While such an index is arbitrary, it is convenient for comparison in the investigation of our own cases, and unless something better is devised we would recommend its use.

At the same time, as already noted, for comparison between the counts of different authors a graphic chart should be plotted, as only in this way can the work of different men be compared. We would also state that there can be wide variations between maximum and minimum readings in each class of cases, our cases showing:

	Minimum.	Maximum.
Good cases	32.25	69.25
Medium cases	38.0	70.5
Bad cases	61.5	87.0
Very bad cases	73.5	90.5

While Webb and Williams get:

	Minimum.	Maximum.
Normal cases	50	86
Cured cases	29	88
Improving cases	47	91
Stationary cases	31	94
Advancing cases	31	91

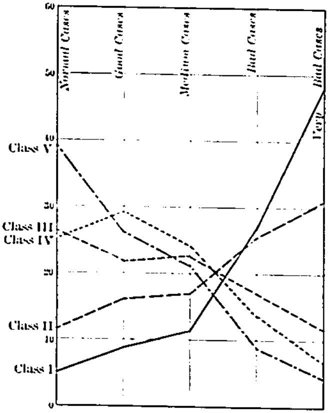
As we were studying the bearing of these counts on the prognosis of our cases we divided the hundred cases not according to the classification of Turban or the National Association, since certain Stage I cases can be severe or of bad outlook, while certain Stage III cases may be favorable and slow in course, but according to their clinical and prognostic outlook, classing them as good, medium, bad, and very bad, this classification being done by Dr. Minor from his knowledge of the cases without previous study of their counts, while Dr. Ringer, when he made the counts, took pains not to inform himself of the prognostic outlook of the cases.

Of course, the fault of this method is the personal equation which may enter into it, but for use in one's practice in studying one's cases prognostically this seems to us much the most practical division.

Webb and Williams have divided theirs into cured, improved, stationary, and advancing.

Tabulating our hundred cases in this way, we arranged them in four classes, and were surprised to find with what uniformity they bore out the contention of Arneth:

	I	II	III	IV	V	Average index.	Leukocytes.
Average of 10 normal cases. .	2.5	18.0	56.0	19.0	1.5	48.5	....
Average of 31 good cases .	4.5	21.5	46.0	22.0	3.0	52.69	7988
Average of 30 medium cases .	5.5	25.5	48.0	18.5	2.5	51.85	9827
Average of 25 bad cases . .	13.5	38.5	36.5	10.5	1.0	70.82	9258
Average of 14 very bad cases .	24.0	45.5	25.0	5.0	0.5	88.03	20 200



Relative position and change in each group.

A glance at this chart, which, as I have said, was not forced in any way, will surprise one by the regularity with which, in Classes I and II, the figures rise through the light cases to the very bad; how in Class III there is a much slighter rise; while in Classes IV and V there is, on the contrary, a fall, the general increase in the lower classes being well shown by the index.

This is made even more apparent when these are plotted out in graphic curves.

A study of these tables certainly seems to justify the belief that the discovery of a distinctly poor picture in a case can have real prognostic value, and that even when the clinical course of the case seems favorable a bad picture should cause us to look out for unfavorable developments.

Thus, in one of our cases, a young man (Mr. W. B.), who, as already noted, seemed to be doing well, we were surprised to find a picture:

I	II	III	IV	V	Index
20	45	30	5	0	80

unexplainable by the apparently satisfactory state of the case, but which was shortly followed by a severe exacerbation of the trouble which spread rapidly and ended fatally in a few months. One month from the first reading we found:

I	II	III	IV	V	Index
38.5	49.5	10.5	1.5	....	93.5

It must, however, be carefully noted that small variations should not be considered of value, and that there must be distinct changes before we proceed to draw conclusions from them.

In old cases a study of the picture over a series of months will usually show a rise or fall of the index according as the case is running down or up hill, but in any given case we should not expect notable changes under two or three months, unless, as in the case cited just before, there is a rapid extension, or unless a severe hemorrhage occurs, when naturally the number of newly formed leukocytes is increased.

Thus, in one severe case (J. M. H.) we found on December 4, 1908:

I	II	III	IV	V	Index
15.0	50.0	22.5	11.5	1.0	76.25

And on February 11, 1909, just after a large hemorrhage:

I	II	III	IV	V	Index
33.5	50.5	13.0	3.0	0	90.5

while, though he continued to go down hill, on March 26, 1909, he showed:

I	II	III	IV	V	Index
27.0	49.5	20.5	3.0	0	86.75

thus showing that the hemorrhage, by causing a formation of many new leukocytes, had artificially raised his index.

The rapid deterioration which can occur in a severe case is well shown in readings only a month apart in the case of caseous pneumonia we referred to earlier (H. M. S.). Here, on March 2, 1909, we found:

I	II	III	IV	V	Index
15.0	40.0	40.0	5.0	0	75.0

while on April 5, 1909, we found:

I	II	III	IV	V	Index
34.0	45.0	20.0	1.0	0	89.0

In a severe case with general dissemination over both lungs (E. H.), which after a long course and the greatest care was slowly recovering his health and has since gone home "arrested," we were unfortunately not using this method on his arrival, February 27, 1908; but on December 1, 1908, when he was in very good condition, but by no means in the excellent shape he showed on discharge, we found:

I	II	III	IV	V	Index
10.5	35.5	35.5	17.5	1.0	73.7

while on May 29, 1909, shortly before his return to Chicago, we found:

I	II	III	IV	V	Index
5.0	34.0	50.0	11.0	0	64.0

Again, in a severe case of chronic tuberculosis with great prostration and much active tissue destruction in the lungs (I. W. S.), he showed on March 18, 1909:

I	II	III	IV	V	Index
32.5	47.0	16.5	4.0	0	87.75

while, after very satisfactory though slow improvement, with increased weight and appetite, markedly decreased fever, cough and expectoration, and great improvement in the physical condition of the lungs, he showed, on May 26, 1909:

I	II	III	IV	V	Index
18.0	48.5	28.5	5	0	80.75

a relatively slight change, but one which, viewed in connection with his clinical improvement, distinctly increased our hopes of final betterment.

Again we will find cases which, despite good gains, show a rising index, and here we have come to feel that such a rise detracts greatly from the meaning of such improvement. Thus, in a severe case with bad pulmonary, laryngeal, and probably intestinal lesions, the patient made considerable gain. The laryngeal trouble was less active, the diarrhœa ceased, and while the physical findings in the lungs only moderately improved, the symptoms did. Nevertheless, on November 26, 1908, this case (M. L. D.) showed:

I	II	III	IV	V	Index
14.0	50.0	30.5	5.5	0	79.2

and on December 29, 1908:

I	II	III	IV	V	Index
24.0	49.0.	24.5	2.5	0	85.2

and the course of this case since that time, though another count has not been made, would seem to indicate that the index was a reliable guide.

Again, a pulmonary and laryngeal case (M. N. G.), which for some time gained weight and made some improvement, but has not held these gains in the last month or so, showed, on November 24, 1908:

I	II	III	IV	V	Index
10.0	43.5	35.0	11.5	0	71.0

and on January 8, 1909, although she seemed to be still doing well:

I	II	III	IV	V	Index
13.5	43.5	36.5	5.0	1.5	75.25

We could cite many more pictures, were it necessary, which would show the utility of this method of counting the blood, but we believe we have presented enough to make this clear.

While it is far from infallible, it is nevertheless a distinctly valuable guide in the formation of a prognosis, though as we have tried to show, it will not do to draw large conclusions from slight variations in the blood pictures, either from month to month or at first examination.

Like every other method of clinical medicine, it should be used conservatively and judiciousy, but if so used we feel that it will prove a valuable addition to our clinical methods.

Nearly two years have elapsed since the above paper was written, and we have had ample opportunity to test the matter further, and have used it in nearly 500 cases. As a result of this work we are more than ever satisfied of the correctness of the conclusions we drew at that time.

A few cases may here be cited among many that we have examined:

In April 17, 1909, H. A., a second-stage case, after some months of cure was doing remarkably well, had lost all constitutional symptoms, cough and expectoration were slight, weight excellent, and general outlook good. At this time his blood read:

I	II	III	IV	V	Index
4	16	48	30	2	44

Since this time family troubles and financial difficulties necessitated hard work beyond his strength; he has been steadily running down hill; the lesions in his lungs have increased; the larynx is seriously involved, and the outlook we consider bad. On March 11, 1911, we found:

I	II	III	IV	V	Index
41	41	17	1	0	90.5

On the other hand, M. J. E., on arrival, March 11, 1910, had a severe and active process, chiefly in left lung, and showed:

I	II	III	IV	V	Index
25	54	19	1	0	89.5

He made rapid and remarkable gains, and by July 1, 1910, he showed:

I	II	III	IV	V	Index
12	40	41	6	1	72.5

while now (March 15, 1911) his process is arrested and his reading is:

I	II	III	IV	V	Index
2	37	54	7	0	66

I. N. R., a medical student, arrived March 17, 1909, with an active bilateral process with tendency to frequent "congestions." At that time his reading was:

I	II	III	IV	V	Index
27	46	19	8	0	82.5

With care, by May 19, 1910, all activity had ceased and he was classed "apparently cured," a condition which has since continued. He then showed:

I	II	III	IV	V	Index
3	38	48	10	1	65

Miss M. G. G. arrived June, 1910, with a very acute process, with high fever, marked symptoms, and a diffuse involvement of her right lung, with a very grave prognosis. July 20, 1910, her reading was:

I	II	III	IV	V	Index
18	56	26	0	0	87

November 22, 1910, after four months of unexpectedly favorable progress, with symptoms greatly reduced and signs improving, she showed:

I	II	III	IV	V	Index
8	39	41	11	1	67.5

and went home apparently cured March, 1911. Unfortunately, a last blood count was not made.

Mr. E. S. T. had done very well, and after six months of care showed, May 14, 1910:

I	II	III	IV	V	Index
8	28	52	12	0	62

Returning home to great business anxiety and overwork, he later developed laryngeal trouble, and on return, November 28, 1910, showed:

I	II	III	IV	V	Index
9	49	39	8	0	72.5

These are but a few of the cases that have caused us to rely on this method for aid in drawing our prognosis and justify us in recommending it to the profession.

There have been cases in which it has failed us, but there have been very many, the large majority of all those seen, in which it has been of distinct value, and where the course of the case has verified the predictions of this method.

SOME EXPERIENCES WITH THE EINHORN DUODENAL BUCKET AND A MODIFIED THREAD TEST.[1]

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In April, 1909, Dr. Max Einhorn described the use of his duodenal bucket and the thread impregnation test as an aid to the diagnosis of, and as a means for the location of, peptic ulcers. Shortly afterward I employed this procedure in several cases, but later adopted a modification in place of the bucket, which I will describe.

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[1] Read before the American Gastro-Enterological Association at St. Louis, June 6, 1910.